The potential of forests and forest industry in reducing excess atmospheric carbon dioxide

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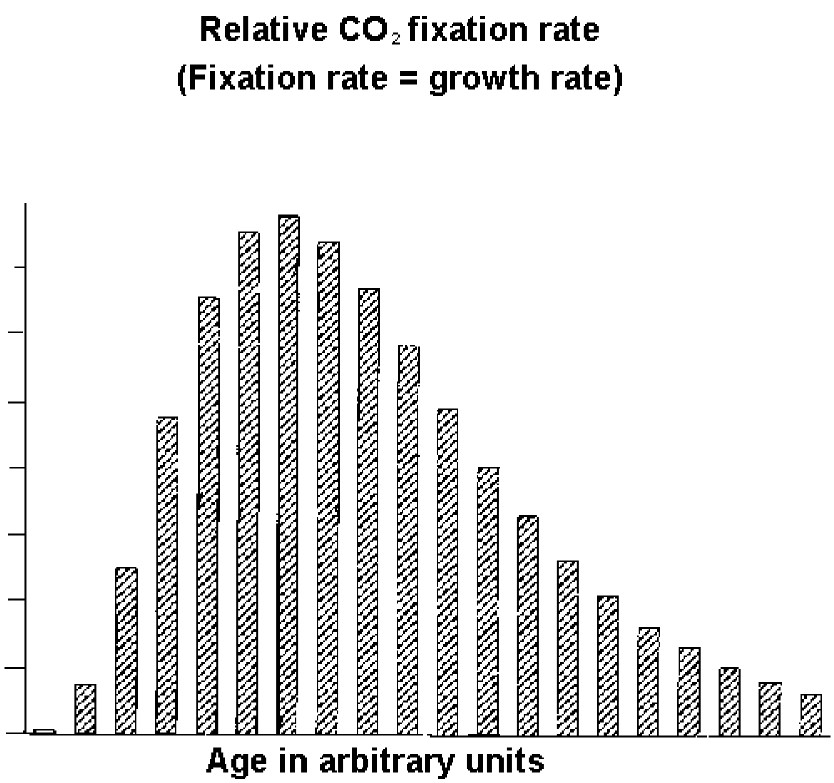
The tropical forests are often described as the "green lungs" of the earth by the popular press. The underlying implication of this characterization is that these forests absorb more carbon dioxide (CO2) during the daytime in the process of photosynthesis than they emit at night through respiration. This is true for healthy, growing trees, but not necessarily for a forest as a whole. Forests with net growth are capable of net absorption of CO_2, whereas mature forests with little growth hold carbon stocks but are unable to absorb additional CO_2. Forests that experience a net loss of biomass volume through mortality due to overmaturity, disease or fire become net emitters of CO_2.

An undisturbed moist tropical forest exhibits net growth for about 100 years after its establishment. After this, as far as CO_2 is concerned the forest reaches a state of equilibrium; emission at night equals daytime absorption. If such a forest is left undisturbed for even longer periods, owing to over-maturity of the stand, it will probably become a net emitter of CO_2.

Forest growth is usually described in terms of annual yield over a given period. In many cases this has led to the misunderstanding that trees grow at a constant rate. This is very far from the truth, as can be seen from the schematic presentation of incremental annual growth of the tree biomass as a function of age in the Figure. Since rate of CO_2 absorption is directly proportional to the rate of growth, it stands to reason that "preservation" of natural forests is a relatively inefficient means of sequestering CO_2. On the other hand, forest management based on harvesting at the optimal rotation, efficient conversion of the wood into durable products and appropriate regeneration would maximize the sequestering of CO_2.

Of course, there is a limit to the extent to which such a forest utilization strategy could be applied; from the point of view of ecosystem maintenance, environmental stability, provision of habitat for local people and management of biodiversity, as well as market considerations, industrial utilization of all natural forests is clearly not feasible.

Typical incremental growth rate/carbon dioxide fixation rata of a tree as a function of its age



Intensive tree planting:

Another approach to reducing atmospheric CO_2 through forestry that has received much attention is intensive and extensive planting of trees. According to estimates from the United Nations Environment Programme (UNEP, 1987), the annual net atmospheric increase of CO_2 is approximately 3000 million tonnes of carbon equivalent (tCe). If 1 m3 of growth in forest biomass (stem, roots, branches, etc.) absorbs 0.26 GtCe (Brown et al., 1986), then to compensate for increases in atmospheric CO_2 an area of 465 million ha of new forest would be required in areas where the average rate of growth is 15 m3/ha/year. However, the practicality of such an approach seems very doubtful. In much of the developed world average rates of growth are considerably lower; for example, in the Scandinavian countries and Canada average growth is 5 m3/ha/year or less. In the developing countries the average rate of growth could be much higher (perhaps as much as 35 m3/ha/year), provided that select, well-adapted reproductive materials were used and intensive management were to be applied throughout the rotation. However, the question remains whether such vast land areas could be made available, especially in view of the need for land for agriculture (Sedjo. 1989); and whether infrastructure anti staff could be made available on a timely basis. The overall cost would also be prohibitive, especially if these afforested areas were viewed as a source of global CO_2, absorption rather than as a source of direct benefits for the countries concerned. Finally, the same limitation that applies to natural forests is valid for those made by humans; unless managed and harvested at maturity, they will exhaust their capacity to absorb additional atmospheric CO_2. Industrial plantations in the tropics are an efficient carbon dioxide sink. More intensive use of industrial plantations could be a potential solution for lack of space for natural re-growth of forests.

On the other hand, increased CO_2 sequestering through appropriate sustained forest management and intensified utilization of wood, from natural forests and particularly from fast-growing plantations, would seem to have significant potential (United Kingdom, 1989; Thompson and Matthews, 1989). It can be estimated from the available statistics (FAO, 1988) that 1087 million m3 of industrial roundwood was consumed in 1986. This is equivalent to 815 million bone-dry tonnes of wood, which in turn corresponds to 0.41 GtCe. Of this total, the equivalent of 85 million bone dry tonnes of wood (0.04 GtCe) was burnt in the recovery boilers of the pulp and paper industry. Some 0.24 GtCe was in the form of industrial residue, of which 0.05 GtCe was recovered for use in pulping and another 0.05 GtCe was left to slowly as sawdust; the remainder was burnt for fuelwood. At least 0.17 GtCe was converted to industrial forest products. Thus, at least 0.27 GtCe or more than two-thirds of the total amount of industrial wood consumed in 1986 was converted into products that did not immediately re-enter the carbon cycle. This is equivalent to almost 10 percent of the estimated current annual increase in atmospheric CO2.

Clearly then, increasing the production of industrial wood products produced from wood obtained on a sustainable basis from managed natural forest, and especially from plantations, would be the most efficient means of using forests to sequester CO_2. By increasing the use of wood from fast-growing plantations - in construction, in window frames, for furniture and for paper it might be possible to increase total industrial consumption of roundwood by as much as 50 percent over the next 10-15 years.

Industrial plantations in the tropics have already reached a stage of development where high yields of wood are feasible on a large scale. From these plantations, harvested every eight years, as much as 3500 m3/ha of wood could be produced over a period of 100 years. This is equivalent to seven times the CO_2 that would be sequestered by the same area of natural forest established at the same time. Compared with a natural forest left undisturbed beyond that time, the absorption of CO_2 in such a plantation becomes infinitely greater.

In pulp manufacture for paper, the diameter of the log is essentially irrelevant from a technological point of view. In fact, hardwood pulpwood is already grown in plantations on a rotation of 5-8 years and pine pulpwood on 12-16 year rotations. Furthermore, technologies have already been developed to permit utilization of smaller diameter logs for saw-milling and veneer manufacture. Therefore, from a utilization point of view, harvest cycles could be reduced to 5-15 years for hardwoods and 1220 years for conifers in the tropics, depending on the end use and local conditions. Assuming a yield for hardwoods of 35 m3/ha/year, this would mean sequestering about 9 tCe of CO_2/ha/year.

In view of this, perhaps governments and political pressure groups should reconsider some of their policies with regard to industrial use of wood, especially from the tropics. In fact, a strong argument can be made for increased allocation of financial resources to the development of appropriate forest industries, particularly in the tropics. Certainly such investment would be welcomed by the nations of the developing world.

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